

ANALYSIS AND SOLUTION FOR RESOLVING HYDRAULIC HOSE FAILURES IN BACKHOE LOADERS

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ABSTRACT

This project describes about the case study of hoses in field issues and means to reduce the warranty claims of hose failures. The study was done by analysing how and why the hose fails in the Backhoe loaders and explores solution for rectification. In backhoe loaders, hoses plays a vital role, as only with the help of hoses, the backhoe loaders will be able to move the cylinders to operate the bucket and the hoe. To ensure optimum hose performance, we should have pressure or vacuum characteristics of the system, operating temperature, flexibility required in the application, types of medium being transmitted and environmental condition with which the hose exterior must withstand. This project covers a major area to exhibit the exact application of root cause analysis to diminish product defects. This project work also discusses implementation and solution aspects in product area by instructing the suppliers to rectify regarding the field failure hose. The hoses will be constructed with different number of braids. Based on flow requirement, hose size will be selected.

KEYWORDS: *Hoses, Backhoe Loaders, The Burst Pressure Test, The Proof Pressure Test, The Hold Test & The Warp Test*

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1. INTRODUCTION

An excavator loader is an intriguing creation, as it is truly three bits of advancement equipment combined into one unit. An excavator loader could be a tractor, a loader, an excavator. Each piece of equipment is fit to a particular sort of work. On an ordinary structure site, the excavator overseer as a general rule uses every one of the three sections to deal with business. The focus structure of an excavator loader is the tractor. Much equivalent to the tractors that farmers use in their fields, the excavator tractor is proposed to move adequately over a wide scope of disagreeable scene. It has an amazing, turbocharged diesel engine, colossal, extreme tires and a taxi with basic coordinating controls (a controlling wheel, brakes, and so on). Similar to the way that the loader is associated inside the front, the excavator is associated inside the back. These two parts serve altogether different functions. The loader can do a few distinctive things. In a few applications, it is used as a kind of a tremendous, ground-breaking dustpan and it is utilized to get and convey enormous measure of free material. The excavator is the primary apparatus of the excavator loader. Its acclimated inquiry out hard, smaller material, regularly earth, or to raise critical masses, similar to a sewer box. It will raise this material and drop it in an exceedingly heap to the aspect of the opening. The stabilizer legs are pivotal to excavator activity, since they take the brunt of the weight when an excavator is burrowing. Without the stabilizer legs, the weight of a huge burden or the descending power of exhuming into the base would strain the haggles, and furthermore, the entire tractor would ricochet always. The stabilizer legs have two sorts of "shoes," with the goal that they can be planted safely on both soil and asphalt to

verify the tractor.

Advancement industry OEMs, for instance, Caterpillar Inc., (Cat), Komatsu Ltd., besides, J C Bamford Excavators Ltd., produce considerable equipment for various organizations, for instance, excavator loaders, wheeled loaders and water driven excavators for managing enormous and overpowering materials for various undertakings. Over 45% of the world's improvement machines are weight driven excavators [1], due to their high proficiency and straightforwardness of movement stood out from other advancement machines [2]. Most excavators are fuelled by a consuming engine. As opposed to a customary vehicle, the made force of the engine is transmitted to drive the water-controlled siphons, which give the stream inside the weight driven structure. Waterpower is the investigation of transmitting power and moreover, development through the vehicle of a bound liquid, and power is transmitted by pushing on this constrained liquid. Siphons are acquainted with induce the oil around the circuit and, now and again, pressurize it. Valve squares are consistently used to control the stream and course of the oil. These are metal castings in which oil ways or shows are crossed by valve spools, the amount of which depends upon the amount of organizations to be controlled. Dissatisfaction of control valves can cause lost creation which is ordinarily more exorbitant than the cost of neutralizing activity [3]. The basic assistant pieces of an excavator, for instance, the impact, scoop arm, compartment and slew motor are moved by water driven rams. Weight driven rams convert fluid power into straight power and development. The immediate power made by a weight driven crush is a consequence of system weight and fruitful region, less structure inefficient perspectives. The multifaceted idea of off-interstate excavators' water driven circuits and the exceptional working conditions they ought to endure, suggests that the reliability of such systems is reliably an authentic idea [4]. Investigation of water fuel structure errands shows that the unflinching nature of the system and its sections will depend upon a huge number of components [5], counting weight, stream, temperature, consistency and particulate contaminants [6]. Dave Douglass, the head of getting ready and preparing of Muncie Power Products, Muncie Inc. claims 70–90% of water driven structure frustrations can be credited to spoiled oil [7]. Moreover, The National Research Council of Canada found that 82% of wear issues are inferable from atom started dissatisfactions, for instance, scratched spot, deterioration and shortcoming [8]. The National Fluid Power Centre (NFPC) also stresses, in one of their oil sullying the load up courses, that failure to address and suitably manage sullying will incite exorbitant individual time and short part life [9]. Corruption: opportunity estimated particles interface with the two appearances, often causing grinding wear, disintegration and air flow issues [10]. Discontinuous: polluting causes transient block on the valve spool or keeps the poppet valve from moving. Although particulates are most likely going to be washed away by repetitive improvement of the spool, simply complete clearing will guarantee that this mistake won't happen again [11]. Cataclysmic: this happens out of the blue when a few gigantic particles or incalculable little particles cause complete seizure of moving parts [12]. Produced debasement, generally called scratched spot, is realized by contact of water controlled parts during use and isn't always avoidable [13].

The primary target of this task portrays about the contextual analysis of hoses in field issues and to lessen the guarantee cases of hose disappointments. The examination was finished by investigating and to correct how and why the hose bombs in the Backhoe loaders. This task covers a significant region to display the precise use of main driver examination to reduce the item deserts.

1.1 Description Regarding Hydraulic Systems, Loader Bucket and Steering

Caterpillar have been structuring and fabricating pressure driven hoses since the 1960s, refining and testing their items to surpass the base business guidelines. Caterpillar's well-being mentality and unequalled help conveys authentic incentive for your armada - driving better an incentive for your main concern. Pressure driven frameworks essentially transmit powers from

point to point through liquid. Most frameworks utilize an incompressible liquid, a liquid that is as thick as it can get. This kind of liquid transmits about the entirety of the first power as opposed to engrossing some of it. The most ordinarily utilized incompressible liquid in water powered apparatus is oil. In the exceptionally basic water driven machine demonstrated as follows, the administrator pushes on the oil with one cylinder, so the oil pushes on another cylinder, raising it up.

1.2 Designed as a System

Feline water powered hoses and couplings are planned and made as a framework, so you can make certain of a solid, sturdy item. Top notch hoses and couplings will run better for more, sparing you on personal time and working costs.

1.3 Contamination is the Enemy

The main foe of your machine is tainting. It is assessed that up to 85% of water driven disappointments are because of destructive contaminants in the framework. Keeping the framework spotless and free of holes is the way to accomplish most extreme profitability and life out of your pressure driven parts.

Worked for quality and life span, Caterpillar pressure driven hose is created from top notch elastic equations that are both solid and adaptable, with built winding wire fortification for greatest quality. The entirety of this is ensured by a very extreme external spread that opposes nearly anything the earth can toss at it: synthetic compounds, climate, temperature and scraped spot. Utilizing PC controlled hose get together machines, our hoses are gathered by guaranteed specialists, checked and tried stringently all through the procedure, before being cleaned and topped for extreme cleanliness. Despite the fact that they're tough, Cat hoses offer adaptability in any circumstance and on any machine. The power through pressure is the core of your machine, so you'll need to keep them in 100% running request. Keeping up your power through pressure won't just improve your everyday tasks; it will likewise have an immediate result on your primary concern. Dependable and proficient power through pressure make the working day run all the more easily, and, when well-kept up, your water power will assist you with accomplishing more in your activity. It's the seemingly insignificant details that issue on huge machines. You probably won't put a lot of thought into the hoses on your machine, however that doesn't make a difference, since we do, how enormous, or how little, everything on your Cat machine is produced for ideal continuance under the hardest of conditions. Caterpillar started structuring and assembling hose items during the 1960s and they've kept up a worldwide notoriety for predominant execution and dependability from that point forward. The way in to their structure is putting security first. Working intimately with Caterpillar, our group at We strick are reliably creating and refining our assembling advancements to guarantee the most ideal exhibition and unwavering quality in our hoses and couplings. Cat® hoses withstand the hardest conditions where extraordinary scraped area obstruction is an absolute necessity. We utilize the selective Caterpillar-structured polyethylene spread that can withstand more than 2,000,000 scraped area test cycles. They're additionally exceptionally impervious to synthetic concoctions and adapt to enduring in the most extraordinary conditions. Feline hose and coupling frameworks are produced and tried as a pair - not independently - so you can confide in their capacity to cooperate to offer the ideal fit for most extreme security and reliability.

1.4 Loader Bucket Description

A loader is an overwhelming gear machine utilized in development to clear out or stack materials, for example, black-top, destruction flotsam and jetsam, soil, day off, rock, logs, crude minerals, reused material, shake, sand, woodchips, and so on into or onto another kind of apparatus. Loader is a sort of tractor, normally wheeled, once in a while on tracks, that has a

front-mounted square wide can be associated with the finish of two blasts (arms) to gather up free material starting from the earliest stage, as earth, sand or rock, and move it starting with one spot then on to the next without pushing the material over the ground. A loader is usually used to move an amassed material from ground level and store it into an anticipating dump truck or into an open channel removal. The loader get together might be a removable connection or for all time mounted. Frequently, the pail can be supplanted with different gadgets or apparatuses for instance; many can mount forks to lift substantial pallets or shipping compartments, and using pressurized water opening. The can likewise be increased with gadgets like a bundle grappler for taking care of huge bunches of feed or straw. Huge loaders, for example, the Kawasaki 95CV-2, John Deere 844K, ACR 700K Compact Wheel Loader, Caterpillar 950H, Volvo L120E, Case 921E, or Hitachi ZW310 as a rule have just a front container and are called front loaders, while little loader tractors are frequently additionally outfitted with a little excavators and are called excavators loaders or loader excavators or JCBs, after the organization that initially professed to have concocted them. Different organizations like CASE in America and Whitlock in the UK had been producing excavator loaders a long time before JCB. The loader can accomplish a few unique things. In numerous applications, you use it like a major, ground-breaking dustpan or espresso scoop. You normally don't burrow with it; you for the most part go through it to pick and convey a lot of free material. It's likewise used to cover things up like a margarine blade, or to push soil like a furrow. The administrator controls the loader while driving the tractor.

1.5 Steering

This is a standard mechanical linkage control framework from an excavator. At the point, when you move the stick on the extreme left, it works the spool valves that move the blast from side to side and advance and in reverse. The stick on the extreme right works the spool valves that move the stick and the container. The two focus controls move the spool valves that broaden and withdraw the stabilizer legs.

We found in the last two areas, the excavator arm swivels on four unique pivots (some basin plans have five) and the loader proceeds onward a few pivots. Furthermore, the administrator controls the stabilizer arms and moves the tractor around while stacking. The primary controls for a Caterpillar excavator are two PC style joysticks. Here are the elements of the joysticks:

- The joystick on the left moves the blast and swings the whole excavator from side to side.
- The joystick on the correct moves the stick and the container.
- Pulling the joystick toward you moves the blast or the stick nearer to you, and pushing the joystick away moves the blast or stick more distant.
- Pushing the left-hand joystick to one side swings the whole excavator to one side and pushing the joystick to the correct swings the arm to one side.
- Pushing the right-hand joystick to one side scoops the basin in and pushing it to the correct dumps the can out. Burrowing viably with an excavator requires practice, such as figuring out how to drive a vehicle. The hardest piece of figuring out how to drive is generally focusing on the entirety of the various things going on. It takes a great deal of training to keep the entirety of the different controls in your psyche on the double. Figuring out how to work an excavator is a similar way. Getting something with your arm is staggeringly simple since you move each muscle consequently. In any case, envision how hard it would be on the off chance that you needed to stop and consider each muscle you were moving in that one basic movement. Working the loader is generally

straightforward in light of the fact that it just dumps, raises and brings down. The primary loader control is a joystick on the right-hand side of the administrator. In the event that you pull the joystick back toward you, the main arrangement of water powered rams push out to lift the arms up. At the point, when you push it away from you, the arms lower. To dump out the can, you move the joystick to one side. To scoop the pail in, you move the joystick to one side.

The primary goal of this venture depicts about the contextual investigation of hoses in field issues and to lessen the guarantee cases of hose disappointments. The examination was finished by breaking down and to redress how and why the hose bombs in the Backhoe loaders. This undertaking covers a significant zone to show the careful utilization of underlying driver examination to decrease the item surrenders.

2. CONSTRUCTION, PERFORMANCE AND METHOD

2.1 Construction of Hose

Basic construction of hydraulic hose shown in figure 1 and 2. The Tables 1, 2, 3 and 4 shows predict parameters of description parts. It is also shown in figure 3.

- Tube or Inner Lining
- Reinforcement
- Outer Cover

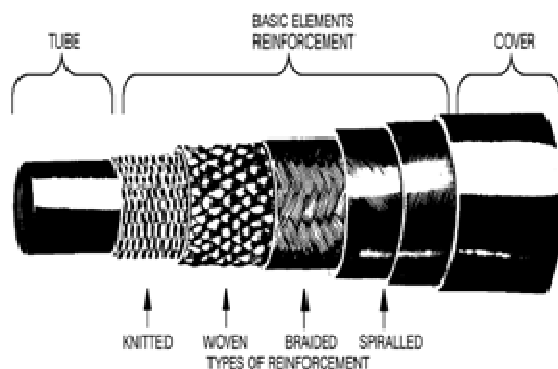


Figure 1: Construction of Hose.

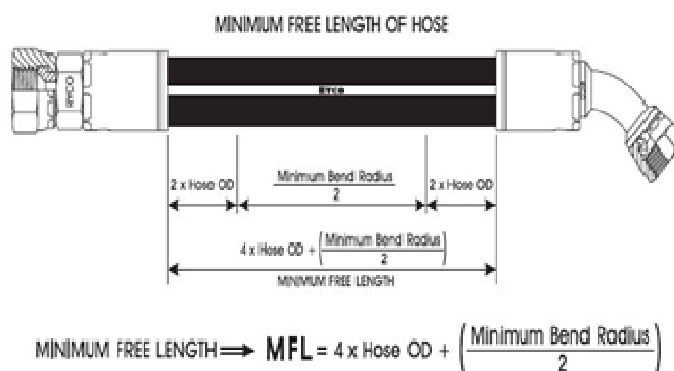


Figure 2: Basic Constraints of Hose.

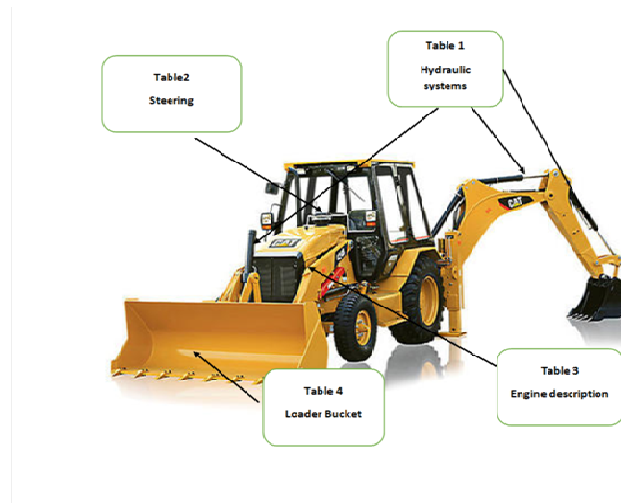


Figure 3: Parts Description.

Table 1: Hydraulic System Performance

Maximum Pump Capacity	132.0 l/min
System Pressure – Backhoe	250.0 bar
System Pressure – Loader	250.0 bar
Type	Closed Centre
Pump Type	Variable Flow, Axial Piston

Table 2: Steering Performance

AWD Cylinder, One (1) Double Acting – Bore	65.0 mm
AWD Cylinder, One (1) Double Acting – Rod Diameter	36.0 mm
AWD Cylinder, One (1) Double Acting – Stroke	120.0 mm
Turning Circle – AWD (inner wheel not braked) – Outside Front Wheels	8.18 m
Turning Circle – AWD (inner wheel not braked) – Outside Widest Loader Bucket	10.97 m
Type	Front Wheel
Power Steering	Hydrostatic

Table 3: Engine Performance

Power Net	66.0 kW
Displacement	4.41
Maximum Torque - 1,400 rpm	394.0 Nm
Model	C4.4 Mechanical Turbocharged and Inter-Cooled
Net Power - 2,200 rpm - ISO 9249	66.0 kW
Note(1)	Net power advertised is the power available at the flywheel when the engine is equipped with fan, air cleaner, muffler and alternator
Note(2)	No derating required up to 2286 m altitude. Auto derate protects hydraulic and transmission systems.
Rated Power (Standard) - 2,200 rpm - Gross - ISO 14396	68.5
Torque Rise - 1,200 rpm - Net	38%
Emissions	Bharat Stage III emission standards
Bore	105.0mm

Table 4: Loader Bucket Performance

Bucket Weight - Excluding Teeth and Forks	611.0Kg
Capacity	0.96 m ³
Digging Depth	147.0mm
Dump Angle at Full Height	46°
Dump Height at Maximum Angle	2764.0mm
Dump Reach at Maximum Angle	825.0mm
Grill to Bucket Cutting Edge, Carry Position	1450.0 mm
Lift Breakout Force	54.0 KN
Lift Capacity at Maximum Height	3475.0 kg
Maximum Bucket Rollback at Ground Level	39°
Maximum Grading Angle	116°
Maximum Hinge Pin Height	3447.0mm
Maximum Operating Height	4368.0 mm
Tilt Breakout Force	60.48 KN
Tipping Load - Breakout Point	7110.0 kg
Width	2262.0mm

2.2 Problem Statement

The main objective of this project is to rectify the defects obtained in a backhoe loader's boom hoses and to find out the causes of failure in hoses of hydraulic systems which also leads to a study on the causes of failure of hydraulic driving lines in different hours of working.

The regular study and analysis of failure mode and instant restoration of good quality hydraulic lines for a backhoe loader will help in determining the factors of increasing problems in warranty claims and solve the biggest problem of commercial issues in frequent warranty claims and replacement of hydraulic conducts and lines (hoses).

2.3 Defects in Hydraulic Lines (The parts are shown in figure 4, 5, 6, 7 and 8)

- Crimp leaks
- Pin hole at the centre
- Burst due to excess pressure

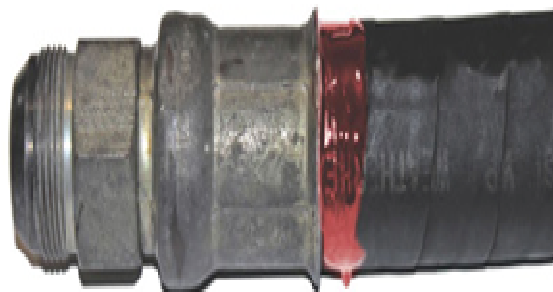


Figure 4: Leak at the Coupling.



Figure 5: Hoses having Internal Tear.

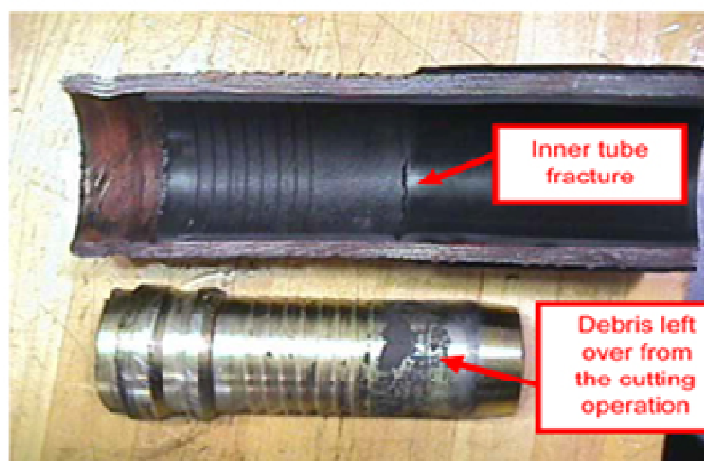


Figure 6: Coupling and Inner Hose Fracture.



Figure 7: Pinhole Defect of the Hose.



Figure 8: Crimp Leak at the End Coupling.

2.4 Crimp Condition

Shreds or free wires at either end of a hose point to over the top hose development, which might be the after effect of vibration or weight floods, or a sign that the hose is excessively short. On the off chance that vibration can be distinguished as the reason, at that point, braces or dampers might be required to help the hose, if re-directing isn't an alternative. It ought to be noticed that a little leeway ought to consistently be allocated to the hose, as congregations recoil when pressurized. Likewise, hoses ought to consistently determine a higher most extreme working weight than the framework itself, so as to represent floods. Winding strengthened hoses are likewise accessible explicitly for serious beating applications, if vital. Hoses are not stationary – they will agreement or stretch as the weight inside them changes. At the point, when hoses rub against objects, together with various hoses anyway especially metal edges, this could prompt scraped spot. Scraped area might be a very normal explanation behind water powered hose disappointment and happens once the external cowl of a hose is eroded to the reason for uncovering the fortifying steel wires. This can in the long run outcome in spills. To limit scraped spot, a few hoses have plasticizers added to the material that makes up the hose spread. On the off chance that there are explicit drawback zones, a plastic gatekeeper or nylon sleeve will be acclimated shield the hose.

2.5 Pressure Test Process

A pressure test process gives the accurate data of the hydraulic hoses and their working conditions under different pressures and climatic conditions. The hoses undergo a series of test to exactly know their durability. The fluid is also tested before usage to know their properties of operating the hydraulic systems. This test ensures that the hydraulic system's working hours with the corresponding hose and their working lifetime. This test is the most important for any hydraulic system. The four-common test for automotive hydraulic hoses is

- The burst pressure test
- The proof pressure test
- The hold tests
- The warp tests

2.6 The Burst Pressure Test

This is the most important of the four hydraulic hoses pressure test as it provides the information of how much is the durability of the hoses when operated at the highest pressure in which it can withstand and beyond its limits. The short length of hose is tested in burst pressure test where water is blasted through until the hose fails.

2.7 The Proof Pressure Test

The hydraulic hoses undergo a proof pressure test at a pressure half of the burst pressure. Proof pressure test is done to show (Figure 9) the hoses still withstands sturdily and reliable.



Figure 9: Pressure Testing Apparatus.

The hoses are said to be reliable when it can withstand the level of water without leaking and ripping for a sustained period of time at its proof pressure.

2.8 The Hold Test

Retires from, unpredictable stretching, and so forth are additionally the adversary of a completely utilitarian water powered hose. The hold test, which is led by filling a hose with water set at a particular weight for a particular period of time, searches for different shortcomings in the hose. The unit is furnished with imported/indigenous apparatus for production of value end associations with various strings according to worldwide principles, according to the necessities of our clients and impeccable creasing and testing up to 80,000 PSI.

2.9 The Warp Test

The curve or deviation in hoses beginning to conveyance point can likewise cause a diminished effectiveness. The test is performed by passing water into hose at certain confirmation focuses to discover if twist is happening. The twist happening hoses are then supplanted. Twist is the deviation from the straight line attracted from fitting to fitting; the greatest deviation from this line is twist. Initial, an action is taken at ten psi (0.069 MPa) and afterward again at the verification pressure. The qualification between the two, in inches, is that the twist. Typically, this can be an element estimated on plain-woven coat hose exclusively. Rise is a proportion of the tallness a hose ascends from the outside of the test table while under strain. The differentiation between the expansion at ten psi (0.069 MPa) and at the confirmation weight is accounted for to the closest 0.25 inch (6.4 mm). Regularly, this can be an element estimated on plain-woven coat hose exclusively. Wind is a revolution of the free finish of the hose while under strain. A first perusing is taken at ten psi (0.069 MPa) and a second perusing at confirmation pressure. The differentiation, in degrees, between the 10 psi (0.069 MPa) base and that at the confirmation weight is the bend. Turn is reportable as right curve (to fix couplings) or left contort. Remaining at the weight delta and looking toward the free end of a hose, a clockwise turning is correct curve and counterclockwise is left bend. Crimp test could be a live of the adaptability of plain-woven coat hose to face up to a momentaneous weight though the

hose is bowed back forcefully on itself at some degree roughly 18 inches (457mm) from one end. Test is made at weights beginning from sixty-two of the evidence pressures on sizes three inches (76 mm) and 3.5 inches (89 mm) to 87% on sizes under 3 inches (76 mm). This is a check applied to plain-woven coat hose exclusively. Volumetric extension test is pertinent just to explicit kinds of hose, for example, water powered or power controlling hose, and is a proportion of its volumetrically development underneath scopes of inside pressure.

3. TESTING AND VALIDATION

The nominal working pressure for the backhoe loader is 250 bars and the pressure test process of hydraulic hose is thrice the pressure of nominal working pressure using pressure test equipment. With the help of analysis report, we have improved the material and also improved the process at supplier end provide crimp leak. To get better crimping, we have reduced the diameter of the crimp, that is 1mm. To get better co applies between the rubber material and the crimp test was done up to 1000 hours and ensured that no contamination occurs. The hoses undergo a series of test to exactly know their durability. The fluid is also tested before usage to know their properties of operating the hydraulic systems. This test ensures that the hydraulic system's working hours with the corresponding hose and their working life time. This test is the most important for any hydraulic system. To quantify the electrical marvel of the hose, spread the whole get together out straight on a non-conducting surface. Spot the ohmmeter terminals on the attachments in the hose to record the cylinder resistivity. On the off chance that the blanket electrical wonder is wanted, place the terminals on the clasps. This procedure will in general dispose of the best scope of factors, yet it is easy to set up and make the test. The opposition between the attachments or clasps will be estimated with a megohm meter (having a scope of 0.08 to 10.6 megohms, using an estimating voltage of 500 volts over the obscure obstruction) that has predecessor been institutionalized against a best-known obstruction. The obstruction of any hose will be reportable as ohms per foot of hose, as controlled by isolating the entire opposition by scope of feet of hose between clasps.

4. RESULTS AND DISCUSSIONS

We have analysed and found that the hose in the backhoe loader have Cracks and the hoses bursts in the middle area or sometimes it has Pin hole in the centre. And to resolve it, we have found that due to the crimp size variation, these errors occur. And now, we have reduced the crimp size in order to reduce the excess pressure errors in hoses.

By making simple changes to the hose, it can reduce the major defects arising in the backhoe loaders. However, the hydraulic hoses undergo a proof pressure test at a pressure half of the burst pressure. Proof pressure test is done to show the hoses still withstands sturdily and reliable. The hoses are said to be reliable when it can withstand the level of water without leaking and ripping for a sustained period of time at its proof pressure. The predict parameters are shown in figure 10.

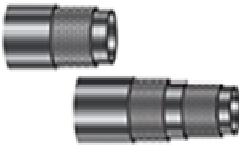

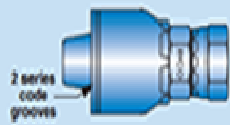
ISOBARIC BRAID HOSE			T1000 COUPLINGS				T2000 COUPLINGS			
										
AVENGER	DIEHARD	SLIDER	CRIMP Ø	MARK LENGTH	RYCO RAPID		CRIMP Ø	MARK LENGTH	RYCO RAPID	
T3000A	T3000D	T3000S	±0.008"	inch	DIE COLOR	RAPID NUMBER	±0.008"	inch	DIE COLOR	RAPID NUMBER
T3004A	T3004D	T3004S	0.598	0.98			0.650	0.98	GRAY	212
T3005A	T3005D	T3005S	0.669	0.98	GRAY	522	0.720	0.98	GRAY	473
T3006A	T3006D	T3006S	0.728	0.98	GRAY	563	0.815	0.98	RED	104
T3008A	T3008D	T3008S	0.854	0.98	LT YELLOW	861	0.933	0.98	LT YELLOW	704
T3010A	T3010D	T3010S	1.035	1.14			1.126	1.18	DK BLUE	625
T3012A	T3012D	T3012S	1.169	1.14	LT GREEN	291	1.260	1.18	LT GREEN	374
T3016A	T3016D	T3016S	1.488	1.34	BLACK	225	1.583	1.33	WHITE	103

Figure 10: Alternated Crimp Size.

5. CONCLUSIONS

We have analysed and found that the hose in the back hoe loader have Cracks and the hoses bursts in the middle area or sometimes it has Pin hole in the centre. On analyzing further for resolution, we have found that due to the crimp size variation, these errors occur. The crimp size has been reduced in order to reduce the excess pressure errors in hoses. On identifying that there is a problem in the boom hose, , we have rectified the boom hose by reducing the crimp size of the hose coupling and was tested again to check if any further errors in the hose occurs or not. Thus, by reducing the coupling size of the hose, no more defects were found.

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